Synopsis

Of the thesis entitled

DEVELOPING WEB BASED MEANINGFUL ENGAGED LEARNING STRATEGY FOR LEARNING ASTRONOMY AT SECONDARY SCHOOL LEVEL

By: Rakhy Radhakrishnan **Supervising Teacher: Dr. P. J. Jacob**

INTRODUCTION

Science is a systematized body of knowledge as well as a continuous search for truth. It is self accumulating, self growing and also dynamic in nature as it revises even universally accepted laws or theories on the basis of new observations and experiments. It has many functions to perform like intellectual, vocational, recreational, moral, social etc. It stimulates imagination, curiosity, nurtures skills like observation, experimentation, problem solving, decision making and above all liberates the human race from the vicious cycle of ignorance, curbing anti social customs, traditions and poverty. This liberating role make Science an inevitable part of school education. Physics is an indispensable part of Science education. In everyday life also, immense practical applications of Physics can be found out. It improves the academic knowledge, develops intellectual honesty, inculcates a spirit of inquiry in students and supplements the learning of other subjects. It opens exciting career opportunities also. So everybody should have a basic knowledge of Physics for further study of modern Science and technology and to utilize this for human welfare.

Astronomy is the study of the whole universe and the objects beyond it. Its application in the making of calendars, the explanation of concepts like day and night, seasons, eclipse, tides etc cannot be ignored. It helped the navigators and thereby provided impetus for trade, commerce, cultural exchange as well as transmission of culture. Astronomy has been made a part of school curriculum due to these applications. Astronomy education eradicates superstitions. Astronomy is included in the school curriculum to understand the history and culture, man’s place in the universe, how it supplement the daily life through its immense practical applications and ultimately to find as well as understand the mystery of this vast, varied and beautiful universe.

"World Wide Web" or simply "Web" is an immense treasure of learning resources in the form of virtual libraries, videos, softwares, audios, blogs etc. which can be used to supplement learning in classroom. Moreover these resources can be accessed by anyone at any time and any place. One cannot ignore this potential of Web technologies in storing, disseminating and retrieving information. The type of learning utilizing the attributes and resources of web constitutes Web Based Learning (WBL). For a subject like Astronomy for which providing first hand experiences is a difficult task, virtual experiences of Moon Phase, night sky, solar system, eclipses, star constellations etc. can be given by means of softwares like Moon Phase simulator, Stellarium Solar system 3D simulator and some related videos and images available on web. By using these web resources, virtual as well as meaningful experiences can be given to students which will engage them in learning and thus lead to effective learning.

Meaningful Engaged Learning is a learning strategy in which students are engaged in meaningful, challenging, authentic, real life activities by grouping them into flexible, heterogeneous groups to satisfy the objectives of learning. This learning strategy is based on the theoretical constructs put forward by Dr. Mike Muir, Director of Maine Centre for Meaningful Engaged Learning at the University of Maine at Farmington. In this strategy, the students are self regulated and are responsible for their own learning. In Meaningful Engaged Learning, the learning takes place in five steps namely, (1) Providing Task (2) Accessing Data (3) Interpret and Produce Data (4) Communicate and (5) Evaluate. By linking the web resources with Meaningful Engaged Learning, a strategy can be developed for learning Astronomy. In this Web Based Meaningful Engaged Learning Strategy, students are meaningfully engaged in learning activities through interaction with others, exploration and other worthwhile tasks. Through the use of this strategy, students will get virtual experiences and thereby help in learning Astronomy easily. Also, while surveying the related literature, the investigator found that there were only few studies in India on Astronomy learning and use of web technologies in learning Astronomy. The investigator thus felt the need for developing Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary School level.

OBJECTIVES OF THE STUDY

The objectives of the study are,

1. To develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level.
2. To analyze the present status of teaching Astronomy at Secondary school level.
3. To find out the achievement in Astronomy of students at Secondary school Level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
4. To compare the achievement in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method for total sample and relevant subsamples.
5. To find out the Interest in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
6. To compare the Interest in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
7. To find out the Reasoning ability in Science of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
8. To compare the Reasoning ability in Science of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
9. To find out the Scientific Attitude of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.
10. To compare the Scientific Attitude of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.

11. To assess the retention of Achievement in Astronomy of students at Secondary school level taught using Web Based Meaningful Engaged Learning Strategy and conventional Activity Oriented Method.

HYPOTHESES FORMULATED FOR THE STUDY

The following hypotheses were formulated for this study.

1. The achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method for total sample and relevant subsamples.

2. The Interest in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method.

3. The Reasoning ability in Science of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method.

4. The Scientific Attitude of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method.

5. The retention of achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method.

METHODOLOGY

The present study was intended to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary School level. Before developing the strategy the investigator analyzed the present status of teaching Astronomy at secondary school level through Normative Survey method. In order to find out the effect of the developed strategy the investigator adopted experimental method. The design selected was pre-test post-test non-equivalent group design (Best & Kahn,2007).

For analyzing the present status of teaching Astronomy through survey method, the investigator selected 120 Secondary school Science teachers from four districts of Kerala selected through Random sampling Method. As Astronomy topics are included in the Standards VIII and X of Kerala State Secondary School Syllabus, the investigator selected the students of both Standards VIII and X studying in the secondary schools of Kerala as the population of the experimental part of the study. The investigator selected a total of 640 students from Standard VIII (320) and Standard X (320) through Random sampling method.

The sample consists of 320 students belonging to eight divisions of Standard VIII (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district) and eight divisions of Standard X (four divisions from two higher secondary schools in Pathanamthitta district and four divisions from two higher secondary schools in Alappuzha district). Of the schools selected, two were Government schools (Grama Panchayath Higher Secondary School, Kulanada and Government Model Higher Secondary School, Ambalapuzha) and the other two were Aided schools (SVGV Higher Secondary School, Kidanganoor and Devasom Board Higher Secondary School, Thakazhi). From each school, one division of Standards VIII and X, were taught using Web Based Meaningful Engaged Learning Strategy (Experimental Group) and the other division using conventional Activity Oriented Method (Control Group).

The tools used were,

1. Questionnaire to find out the Present Status of Teaching Astronomy in Secondary Schools
2. Lesson transcripts based on Web Based Meaningful Engaged Learning Strategy (for Standards VIII and X) (Prepared by the Investigator)
3. Lesson transcripts based on conventional Activity Oriented Method (for Standards VIII and X) (Prepared by the Investigator)
4. Raven's Standard Progressive Matrices
5. Achievement Tests in Astronomy (for Standards VIII and X) (Prepared by the Investigator)

6. Astronomy Interest Inventory (Prepared by the Investigator)
7. Test of Reasoning Ability in Science (Prepared by the Investigator)
8. Scientific Attitude Scale (Prepared by the Investigator)

Procedure Adopted in the Study

A preliminary survey was conducted among 120 science teachers to find out the present status of teaching Astronomy at Secondary school level. After comparing the previous achievement in Physics and General Mental Ability of Standards VIII and X students, the students were divided into two groups namely Experimental group and Control group for both Standards VIII and X. Before starting the experimental treatment, the investigator administered Achievement tests in Astronomy, Astronomy Interest Inventory, Test of Reasoning ability in Science and Scientific Attitude Scale as Pre-tests for both groups belonging to Standards VIII and X. Then the Experimental group was taught using Web Based Meaningful Engaged Learning Strategy and the Control group through conventional Activity Oriented Method. After the experimental treatment, the tests given as Pre-tests were administered as Post-test for both groups of Standards VIII and X. About one month after the administration of Post test, a Delayed Post test on Achievement in Astronomy was also administered to both groups of Standards VIII and X. The response sheets were collected back and scored.

Statistical Techniques Used

The scores obtained by the students in the Pre-test and Post-test were collected, tabulated and subjected to appropriate statistical techniques. The major statistical techniques used are 't' test, ANOVA and ANCOVA.

MAJOR FINDINGS OF THE STUDY

The major findings that have emerged from the study are given below.

I. Present Status of Teaching Astronomy

1. Most of the Physical Science teachers feel difficulty in teaching Astronomy despite providing teacher's handbook.

2. Most of the Physical Science teachers are not able to conduct night sky observations, visit Planetariums and utilize the benefits of Smart classrooms for teaching Astronomy.
3. Despite there are some instructional strategies, the curriculum transaction method in the present context is not appropriate for the Astronomy topics at secondary school level.
4. Even though some Physical Science teachers are utilizing the available resources for teaching Astronomy, majority are not doing the same to a greater extend.
5. An alternate strategy for teaching Astronomy at secondary school level which can provide virtual experiences in the classroom itself utilizing the web resources available on Astronomy, at day time must be developed.

II. Initial Comparison of Experimental and Control groups

A. Standard VIII

6. Before starting the experimental treatment, the students of Experimental and Control groups were compared with respect to their Previous achievement in Astronomy (t = 0.01), General Mental ability (t = 0.04), Achievement in Astronomy (t = 0.05), Interest in Astronomy (t = 0.11), Reasoning Ability in Science (t =0.36) and Scientific Attitude (t = 0.11). All these values are not significant at 0.05 level.

B. Standard X

7. Before starting the experimental treatment, no significant difference (at 0.05 level) was found between the students of Experimental and Control groups with respect to their Previous Achievement in Astronomy (t =0.03), General Mental ability (t =0.30), Achievement in Astronomy (t = 0.12), Interest in Astronomy (t =0.43), Reasoning Ability in Science (t =0.52) and Scientific Attitude (t =0.30).

III. Achievement in Astronomy

A. Standard VIII

8. The analysis of Post-test scores (t =8.47) and Gain scores (t =9.69) on Achievement in Astronomy of Experimental and Control groups revealed that the

two groups differ significantly at 0.01 level. The values of critical ratio and mean scores helped to state that the Experimental group achieved more than Control group with respect to the Achievement in Astronomy.

The analysis of Variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx = 0.00) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy = 71.30) at 0.01 level. This shows that the Experimental group performed higher than the Control group in Post-test.

The analysis of Co-variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx = 100.31), at 0.01 level. From the value of Fyx, it is clear that the final mean scores of students in the two groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores on Achievement in Astronomy of the students in the Experimental and Control groups were compared, the difference between them was found to be statistically significant. The obtained t value (10.02) is significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through conventional Activity Oriented Method.

9. The analysis of the Post-test scores on Achievement in Astronomy with respect to sub-sample categories namely gender and type of School revealed that the Experimental group scored significantly higher than the Control group among boys(t=7.69) and girls (t=9.04) and students of Government(t=8.01) and Aided(t=8.99) schools. All these values are significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through conventional Activity Oriented Method under the sub sample categories namely gender and type of school.

B. Standard X

10. On comparing the Post-test scores (t =8.91) and Gain scores (t =11.09) of Experimental and Control groups it was revealed that the two groups differ significantly at 0.01 level. These values of critical ratio and mean scores helped to state that, the Experimental group achieved more than Control group with respect to the Achievement in Astronomy.

    The analysis of Variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx = 0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy = 78.96) at 0.01 level. This shows that the Experimental group performed higher than the Control group in Post-test.

    The analysis of Co-variance of Pre-test and Post-test scores on Achievement in Astronomy of students in Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx = 134.74) at 0.01 level. From the value of Fyx, it is clear that the final mean score of students in the two groups differ significantly after they were adjusted for the difference in the Pre-test scores.

    When the adjusted means of Post-test scores on Achievement in Astronomy of the students in the Experimental and Control groups were compared, the difference between them was found to be statistically significant. The obtained t value (11.61) is significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through conventional Activity Oriented Method.

11. The analysis with respect to sub-sample categories namely gender and type of School revealed that the Experimental group scored significantly higher than the Control group among boys(t=8.95) and girls (t=8.91) and students of Government(t=9.39) and Aided(t=8.45) schools. All these values are significant at 0.01 level. This shows that the students taught through Web Based Meaningful Engaged Learning Strategy achieved more than those taught through conventional

Activity Oriented Method under the sub sample categories namely gender and type of school.

IV. Achievement in Astronomy under the category of Objectives

A. Standard VIII

12. While analysing the Pre-test scores on Achievement in Astronomy of Experimental and Control groups under different categories of objectives, it was revealed that the critical ratio obtained is not significant at 0.05 level (Knowledge-1.57, Understanding-1.03, Application-0.19, Analysis- 0.11, Synthesis-1.68 and Evaluation-0.64).This shows that the Experimental and Control groups do not differ significantly on Achievement in Astronomy under the different categories of objectives before starting the experimental treatment.

    When the Post-test scores on Achievement in Astronomy under different categories of objectives were compared, the critical ratio obtained is significant at 0.01 level (Knowledge-3.52, Understanding-6.95, Application-6.99, Analysis-5.13, Synthesis-4.31 and Evaluation-4.01).This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Post-test scores of the two groups reveals that after the experimental treatment the Experimental group achieved better than the Control group.

    When the Gain scores on Achievement in Astronomy under different categories of objectives were compared, the critical ratio obtained is significant at 0.01 level (Knowledge-2.19, Understanding-6.14, Application-7.37, Analysis-4.14, Synthesis-4.61and Evaluation-3.36).This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Gain scores of the two groups reveals that, after the experimental treatment, the Experimental group achieved better than the Control group. Thus it can be inferred that the experimental group taught through Web Based Meaningful Engaged Learning Strategy achieved better than the Control group which was taught through conventional Activity Oriented Method with respect to the Achievement in Astronomy under different categories of objectives.

Through the analysis of Variance of Pre-test (Fx) and Post-test (Fy) scores of students in the Experimental and Control groups on achievement in Astronomy under the different categories of objectives it was found that there was no significant difference between the means of Pre-test scores of the two groups. The value of Fx for the objectives are, Knowledge-2.45, Understanding-1.05, Application-0.04, Analysis-0.01, Synthesis-2.81 and Evaluation-0.40. All these values are not significant at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups under the different categories of objectives (The value of Fy for objectives: Knowledge-12.34, Understanding-48.06, Application-48.58, Analysis-26.15, Synthesis-18.48 and Evaluation-15.96). This shows that the Experimental group is superior to that of the Control group in the Post-test of Achievement in Astronomy under different categories of objectives.

The analysis of Co-variance of Pre-test and Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives showed that there is significant difference between the means of Post-test scores of the two groups at 0.01 level. The value of Fyx for objectives: Knowledge-10.08, Understanding-46.71, Application-53.78, Analysis-26.97, Synthesis-20.44 and Evaluation-15.95. The significant Fyx ratio reveals that the final mean scores on Achievement in Astronomy under the different categories of objectives of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores of students in the Experimental and Control groups on Achievement in Astronomy under the different categories of objectives were found and tested for significance using t test, the obtained t values for objectives: Knowledge-3.31, Understanding-6.85, Application-7.33, Analysis-5.19, Synthesis-4.54 and Evaluation-4.00, are significant at 0.01 level. This leads to the inference that the students in the Experimental and Control groups differ significantly with respect to Achievement in Astronomy under the different categories of objectives namely Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation.

B. Standard X

13. The analysis of the Pre-test scores on Achievement in Astronomy under different categories of objectives revealed that the critical ratio obtained is not significant at 0.05 level (Knowledge-1.19, Understanding-1.19, Application-0.70, Analysis-0.68, Synthesis-0.46 and Evaluation-1.61).This shows that the Experimental and Control groups do not differ significantly on Achievement in Astronomy under the different categories of objectives before the experimental treatment.

    When the Post-test scores on Achievement in Astronomy under different categories of objectives were compared, the critical ratio obtained is significant at 0.01 level (Knowledge-3.56, Understanding-7.31, Application-6.68, Analysis-5.55, Synthesis-3.94 and Evaluation-4.85).This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Post-test scores of the two groups reveals that after the experimental treatment the Experimental group achieved better than the Control group.

    When the Gain scores on Achievement in Astronomy under different categories of objectives were compared, the critical ratio obtained is significant at 0.01 level (Understanding-6.64, Application-7.39, Analysis-4.76, Synthesis-3.88 and Evaluation-5.88) except that of the objective Knowledge. For Knowledge the value of 't' is 2.31, which is significant at 0.05 level. This shows that the Experimental and Control groups differ significantly on Achievement in Astronomy under the different categories of objectives. The mean Gain scores of the two groups reveals that, after the experimental treatment the Experimental group achieved better than the Control group. Thus it can be inferred that the experimental group taught through Web Based Meaningful Engaged Learning Strategy achieved better than the Control group which was taught through conventional Activity Oriented Method with respect to the achievement in Astronomy under different categories of objectives.

    The analysis of Variance of Pre-test (Fx) and Post-test (Fy) scores of students in the Experimental and Control groups on achievement in Astronomy under the different categories of objectives showed that there was no significant difference between the means of Pre-test scores of the two groups. The value of Fx for the

objectives: Knowledge-1.47, Understanding-0.45, Application-0.45, Analysis-0.45, Synthesis-0.21 and Evaluation-2.59. All these values are not significant at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups under the different categories of objectives (The value of Fy for objectives: Knowledge-12.57, Understanding-53.14, Application-44.41, Analysis-30.58, Synthesis-15.43 and Evaluation-23.40). This shows that the Experimental group is superior to that of the Control group in the Post-test on achievement in Astronomy under different categories of objectives.

The analysis of Co-variance of Pre-test and Post-test scores of students in the Experimental and Control groups on achievement in Astronomy under the different categories of objectives showed that there is significant difference between the means of Post-test scores of the two groups at 0.01 level. The value of Fyx for objectives: Knowledge-11.40, Understanding-51.38, Application-53.48, Analysis-30.26, Synthesis-16.26 and Evaluation-31.53. The significant Fyx ratio reveals that the final mean scores on achievement in Astronomy under the different categories of objectives of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the adjusted means of Post-test scores of students in the Experimental and Control groups on achievement in Astronomy under the different categories of objectives were found and tested for significance using t test, the obtained t values for objectives: Knowledge-3.38, Understanding-7.18, Application-7.32, Analysis-5.50, Synthesis-4.03 and Evaluation-5.64, are significant at 0.01 level. This leads to the inference that the students in the Experimental and Control groups differ significantly with respect to achievement in Astronomy under the different categories of objectives namely Knowledge, Understanding, Application, Analysis, Synthesis and Evaluation.

V. Interest in Astronomy

A. Standard VIII

14. By analysing the Post-test scores (t =7.48) and Gain scores (t =10.72) with respect to Interest in Astronomy of students in the Experimental and Control groups

revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more interest in Astronomy than the Control group which was taught through conventional Activity Oriented Method.

The analysis of Variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =55.58) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Interest in Astronomy.

The analysis of Co-variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =152.47) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Interest in Astronomy of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Interest in Astronomy of students in the Experimental and Control groups were compared, the t value (t=12.35) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to interest in Astronomy. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more interest in Astronomy than those taught through conventional Activity Oriented Method.

B. Standard X

15. The analysis of Post-test scores (t =6.45) and Gain scores (t =7.50) on Interest in Astronomy of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged

Learning Strategy attained more interest in Astronomy than the Control group which was taught through conventional Activity Oriented Method.

The analysis of Variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.18) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =41.38) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Interest in Astronomy.

The analysis of Co-variance of Pre-test and Post-test scores on Interest in Astronomy of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =63.97) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Interest in Astronomy of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Interest in Astronomy of students in the Experimental and Control groups were compared, the t value (t=8.00) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to interest in Astronomy. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more interest in Astronomy than those taught through conventional Activity Oriented Method.

VI. Reasoning Ability in Science

A. Standard VIII

16. The analysis of Post-test scores (t =5.59) and Gain scores (t =7.26) on Reasoning ability in Science of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Reasoning ability in Science than the Control group which was taught through conventional Activity Oriented Method.

The analysis of Variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.13) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =31.05) which is significant at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Reasoning ability in Science.

The analysis of Co-variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =63.19) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Reasoning ability in Science of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups were compared, the obtained t value (t=7.95) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Reasoning ability in Science. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Reasoning ability in Science than those taught through conventional Activity Oriented Method.

B. Standard X

17. The analysis of Post-test scores (t =6.89) and Gain scores (t =11.45) on Reasoning ability in Science of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Reasoning ability in Science than the Control group which was taught through conventional Activity Oriented Method.

The analysis of Variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.27) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =47.28) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Reasoning ability in Science.

The analysis of Co-variance of Pre-test and Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =146.75) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Reasoning ability in Science of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Reasoning ability in Science of students in the Experimental and Control groups were compared, the obtained t value (t=12.12) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Reasoning ability in Science. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Reasoning ability in Science than those taught through conventional Activity Oriented Method.

VII. Scientific Attitude

A. Standard VIII

18. Through the analysis of Post-test scores (t =3.10) and Gain scores (t =5.45) on Scientific Attitude of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Scientific Attitude than the Control group which was taught through conventional Activity Oriented Method.

The analysis of Variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx =0.01) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =9.56) which is significant at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Scientific attitude.

The analysis of Co-variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =32.17) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Scientific Attitude of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Scientific Attitude of students in the Experimental and Control groups were compared, the t value (t=5.67) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to interest in Astronomy. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Scientific Attitude than those taught through conventional Activity Oriented Method.

B. Standard X

19. The analysis of Post-test scores (t =2.92) and Gain scores (t =6.78) on Scientific Attitude of students in the Experimental and Control groups revealed that there is significant difference between the two groups at 0.01 level. These results shows that the experimental group taught using Web Based Meaningful Engaged Learning Strategy attained more Scientific Attitude than the Control group which was taught through conventional Activity Oriented Method.

    The analysis of Variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there was no significant difference between the means of Pre-test scores of the two groups (Fx

=0.09) at 0.01 level. But there was significant difference between the means of the Post-test scores of two groups (Fy =8.48) at 0.01 level. This reveals that the two groups differ significantly in their Post-test scores on Scientific attitude.

The analysis of Co-variance of Pre-test and Post-test scores on Scientific Attitude of students in the Experimental and Control groups showed that there is significant difference between the means of Post-test scores of the two groups (Fyx =47.40) at 0.01 level. This significant Fyx ratio reveals that the final mean scores on Scientific Attitude of students in the Experimental and Control groups differ significantly after they were adjusted for the difference in the Pre-test scores.

When the difference in adjusted means of Post-test scores on Scientific Attitude of students in the Experimental and Control groups were compared, the t value (t=6.89) obtained is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with respect to Scientific Attitude. Thus it can be inferred that learning using Web Based Meaningful Engaged Learning Strategy helped the students to attain more Scientific Attitude than those taught through conventional Activity Oriented Method.

VIII. Retention of Achievement in Astronomy

A. Standard VIII

20. The comparison between the Experimental and Controls groups with respect to the delayed Post-test scores on Achievement in Astronomy revealed that the 't' value obtained (12.37) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with regard to their retention in achievement in Astronomy in the Post-test scores. The mean scores on delayed Post-test on Achievement shows that the Experimental groups taught through Web Based Meaningful Engaged Learning Strategy is having more retention than the Control groups taught through conventional Activity Oriented Method.

    While comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the experimental groups, the 't' value obtained (1.24) is not significant at 0.01 level. This shows that the Achievement in Astronomy can

be retained even after one month to those students who were taught using Web Based Meaningful Engaged Learning Strategy.

On comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the Control groups, the 't' value obtained (4.98) is significant at 0.01 level. This shows that the Achievement in Astronomy cannot be retained even after one month to those students who were taught using conventional Activity Oriented Method. Thus it can be concluded that the retention of students taught using conventional Activity Oriented Method is less when compared to the retention of students taught using Web Based Meaningful Engaged Learning Strategy.

B. Standard X

21. The comparison between the Experimental and Controls groups with respect to the delayed Post-test scores on Achievement in Astronomy revealed that the 't' value obtained (11.23) is significant at 0.01 level. This shows that there is significant difference between the Experimental and Control groups with regard to their retention in Achievement in Astronomy in the Post-test scores. The mean scores on delayed Post-test on Achievement shows that the Experimental groups taught through Web Based Meaningful Engaged Learning Strategy is having more retention than the Control groups taught through conventional Activity Oriented Method.

While comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the experimental groups, the 't' value obtained (1.29) is not significant at 0.01 level. This shows that the Achievement in Astronomy can be retained even after one month to those students who were taught using Web Based Meaningful Engaged Learning Strategy.

On comparing the Post test and delayed Post-test scores on Achievement in Astronomy of students in the Control groups, the 't' value obtained (4.50) is significant at 0.01 level. This shows that the achievement in Astronomy cannot be retained even after one month to those students who were taught using conventional Activity Oriented Method. Thus it can be concluded that the retention of students taught using conventional Activity Oriented Method is less

when compared to the retention of students taught using Web Based Meaningful Engaged Learning Strategy.

CONCLUSIONS OF THE STUDY

The major conclusions that are arrived at from the study are noted below:

1. The achievement (total) in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method. So it can be concluded that Web Based Meaningful Engaged Learning strategy is better than conventional Activity Oriented Method in learning Astronomy at secondary school level.

2. While comparing the objective wise (Knowledge, Understanding, Application, Analysis, Synthesis, Evaluation)achievement in Astronomy of students in the Experimental and Control groups, it was found that the objective wise achievement in Astronomy of students taught through Web Based Meaningful Engaged Learning strategy is more than that of students taught through conventional Activity Oriented Method. Thus it can be concluded that Web Based Meaningful Engaged Learning strategy is better than conventional Activity Oriented Method in learning Astronomy at secondary school level.

3. While comparing the achievement of students in the Experimental and Control groups under the subsample categories like gender and type of school it was found that the students taught through Web Based Meaningful Engaged Learning strategy achieved more than those taught through conventional Activity Oriented Method. Thus it can be concluded that Web Based Meaningful Engaged Learning strategy is better than conventional Activity Oriented Method on Achievement in Astronomy at secondary school level under the subsample categories like gender and type of school.

4. The Interest in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more interest in Astronomy than those taught using conventional Activity Oriented Method.

5. The Reasoning ability in Science of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more Reasoning ability in Science than those taught using conventional Activity Oriented Method.

6. The Scientific Attitude of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to attain more Scientific Attitude than those taught using conventional Activity Oriented Method.

7. The retention of achievement in Astronomy of students taught using Web Based Meaningful Engaged Learning Strategy is significantly higher than that of those taught using conventional Activity Oriented Method. It can be concluded that Web Based Meaningful Engaged Learning strategy helped the students to gain more retention of achievement in astronomy than those taught using conventional Activity Oriented Method.

EDUCATIONAL IMPLICATIONS OF THE STUDY

The ultimate goal of the present study was to develop Web Based Meaningful Engaged Learning Strategy for learning Astronomy at Secondary school level. The findings revealed that learning Astronomy using Web Based Meaningful Engaged Learning Strategy helps students to gain more Achievement in Astronomy, Interest in Astronomy, Reasoning ability in Science and Scientific Attitude. These findings have certain educational implications for the school education programmes. The implications are outlined below:

1. In order to reveal the mystery of the universe and to understand this, knowledge of Astronomy is essential. Astronomy learning has many limitations. To overcome these limitations and enjoy Astronomy learning, Web Based Meaningful Engaged Learning Strategy is found to be effective and therefore should be introduced in the Secondary school curriculum. In Web Based Meaningful Engaged Learning Strategy, students are heterogeneously and flexibly grouped to increase

cooperation among them. It is a student centered learning strategy. Here the teacher acts as a facilitator, guide and co learner and the student, as an explorer, as well as a cognitive apprentice. The students are self-regulated and are responsible for their own learning. As students are intrinsically motivated, students will generate a lifelong passion to understand and solve problems.

2. The present study has came out with a Web based learning material in the form of a Website specially designed to teach topics on Astronomy of Kerala state secondary school syllabus.
   - The developed web based material helps to provide a simple and unique visual impact on students.
   - Astronomical softwares included in it permits a journey to the virtual representation of outer space, enabling students to zoom in or out as they wish, easily changing their viewpoint and perspective and their by study the different objects of this universe. Such a learning environment will promote learning through exciting learning experiences.
3. Another important contribution of the study, in addition to its wider theoretical and practical implications is that, it has came out with a set of standardized instruments for measuring the variables of the study, viz., Achievement tests in Astronomy (for Standard VIII & Standard X), Astronomy Interest Inventory, Test of Reasoning Ability in Science and Scientific Attitude scale. These tools can be further used widely in the field of education in particular Astronomy education.
4. From the findings of the study, it is evident that Web Based Meaningful Engaged Learning Strategy will enhance the achievement in Astronomy. It proved to be a powerful strategy to overcome the hurdles of Astronomy education to some extent. Our officials should take necessary steps to incorporate this strategy in our curriculum and provide training for teachers in this strategy. Model lesson transcripts on Web Based Meaningful Engaged Learning Strategy should be generated by the experts in education in collaboration with computer personnel. NCERT and SCERT should take initiatives for implementing Web based strategies in the classrooms.
5. This strategy has proved a real way to enhance interest in Astronomy. Generating interest in Astronomy will not only help them to understand the mysterious of this universe but also supplements their daily life through various applications along with exciting career opportunities. Teachers must arrange extracurricular activities

related to Astronomy such as conducting Space camps, exhibitions, projects, workshops, celebrating Astronomy week, arrange interactions with eminent scientists in Astronomy as well as conducting sky watching during various celestial phenomena.

6. It enhances the Reasoning ability in Science of students. Reasoning ability will act as an invaluable asset for students for coping with the ever changing world. There must be provisions in the curriculum itself for improving and enhancing Reasoning ability in students.
7. By learning Astronomy through Web Based Meaningful Engaged Learning Strategy, the level of Scientific attitude among secondary school students is increased. This will make them open minded, curious, honest, objective, and create an ardent love for scientific experimentation. Teachers must plan activities to inculcate Scientific attitude among their students and thus help them to live in this society without the distorting blinkers of superstitions.
8. The results of the study revealed that the developed Web Based Meaningful Engaged Learning Strategy has more effect on the retention of achievement in Astronomy as compared to that of conventional Activity Oriented Method. Hence curriculum developers should take efforts to implement this strategy in the curriculum with minor adaptations to the specific needs of the learners so as to reinforce learning.
9. Although the teaching or learning methods used in this study were not new but they are combined in new ways that had not been done before. This strategy includes the meaningful integration of technology to foster Astronomy learning. It is hoped that this strategy will pave a new way for learning Astronomy by giving virtual experiences in students through the judicious use of Web based resources.
10. The significance of the study is enhanced manifold owing to the lack of such research studies in India as well as Kerala. Hence the findings of the present study is of great importance to curriculum planners, teacher educators, Physical Science teachers etc. as it provides guidelines to make necessary steps to make Astronomy learning more effective, meaningful and interesting.